

CHROMOSOME NUMBERS OF TROPICAL AMERICAN GRASSES (GRAMINEAE): 5^{1,2}

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ABSTRACT

Chromosome numbers and meiotic behavior are reported in 101 collections of grasses representing 42 genera and 85 species. First chromosome reports are given for the following 21 species: *Agrostis turrialbae*, $n = 14$; *Andropogon hypogynous*, $n = 30$; *Axonopus pruinosis*, $n = 30$; *Aristida riparia*, $n = 11$; *A. setifolia*, $n = 11$; *A. torta*, $n = 11$; *A. venesuelae*, $n = 22$; *Chusquea scabra*, $n = 20$; *Festuca chiriquensis*, $n = 14$; *Gymnopogon spicatus*, $n = 10$; *Muhlenbergia lehmanniana*, $n = 10 + 2B$; *Olyra lateralis*, $n = 18$; *Panicum guianense*, $n = 20$; *P. macranthum*, $n = 27$; *P. olyroides*, $n = 18$; *P. pyrularium*, $n = 18$; *Paspalum gardnerianum*, $n = \text{ca. } 20$; *Pereilema brasilianum*, $n = 20$; *Stipa hans-meyeri*, $n = 11$; *Swallenochloa longiligulata*, $n = 20$; *Swallenochloa weberbaueri*, $n = 20$. Counts differing from previously reported numbers are given for the following 5 species: *Axonopus fissifolius*, $n = 30$; *Pappophorum pappiferum*, $n = 50$; *Paspalum carinatum*, $n = 10$; *P. minus*, $n = 25$; *Pennisetum setosum*, $n = 18$.

This paper is a continuation of our earlier studies on the chromosome numbers of tropical American grasses (Pohl & Davidse, 1971; Davidse & Pohl, 1972a, 1972b, 1974). Tropical America continues to be one of the most poorly studied areas in the world in terms of known chromosome numbers of grasses. We intend to continue to provide basic information concerning chromosome numbers and meiotic behavior of tropical American grasses as this becomes available.

Since our review of important contributions dealing with chromosome numbers of tropical American grasses (Davidse & Pohl, 1974), several other papers have been published: Moraes Fernandes et al. (1974), Koch (1974), Hickenbick et al. (1975), and Quarin (1977).

All chromosome counts were made from squashes of microsporocytes. The methods used are those noted in Davidse & Pohl (1972a). Vouchers for the Pohl and the Pinette specimens are deposited in the Iowa State University Herbarium (ISC), and for the Davidse specimens in the Missouri Botanical Garden Herbarium (MO). Voucher slides are available for most of the counts at MO.

RESULTS AND DISCUSSION

A complete list of the species studied, their chromosome numbers, and the voucher specimens is given in Table 1. Two asterisks (**) after a number indi-

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cate that the count is the first for the species; one asterisk (*) indicates that the count differs from any previous one for the same species. The collections are arranged alphabetically by genus and species under their respective subfamilies. Unless otherwise indicated in the text, meiosis was normal for all collections listed in Table 1. New chromosome number determinations and some of those of irregular meiotic behavior or other special interest are illustrated in Figs. 1–30.

SUBFAMILY BAMBUSOIDEAE

The very similar genera *Chusquea* and *Swallenochloa* are here again shown (Figs. 1, 3–4) to have a basic chromosome number of $x = 10$ rather than $x = 12$ as was previously indicated by Janaki Ammal (1959) for three South American species of *Chusquea*. All other earlier counts (Pohl & Davidse, 1971; Davidse & Pohl, 1972b, 1974) have been based on Central American material, so it is important that we have been able to confirm this base number from South America for the first time with a count from *Swallenochloa weberbaueri* (Fig. 3) of the Colombian páramos.

An aneuploid reduction series is characteristic of the genus *Olyra*. Base numbers previously known for this genus include: $x = 7$, *O. fasciculata* Trin. (Calderón & Soderstrom, 1973); $x = 10$, *O. micrantha* (Gould & Soderstrom, 1967; Davidse & Pohl, 1974, this paper), *O. taquara* Swallen (Gould & Soderstrom, 1967); $x = 11$, *O. latifolia* (Tateoka, 1962—fide Calderón & Soderstrom, 1973; Reeder et al., 1969; Pohl & Davidse, 1971; Davidse & Pohl, 1972a, 1972b, 1974, this paper; Kammacher et al., 1973; Olorode, 1975), *O. loretensis* Mez (Gould & Soderstrom, 1970), *O. obliquifolia* Steud. (Gould & Soderstrom, 1967). To the above numbers, we can now add a new base number of $x = 9$ for *O. lateralis* (Fig. 2), which is morphologically anomalous in *Olyra* and will probably be assigned to a new genus in the future. *Olyra cordifolia* H.B.K. has been reported by Gould and Soderstrom (1967) to have $2n = 30$. It would be very desirable to make further counts of *O. cordifolia* to determine whether this count represents a triploid based upon $x = 10$, or, more likely, an aneuploid secondarily derived from a polyploid. Once the genus is better known cytologically, it may be possible to correlate different base numbers and ploidy levels with at least some of the myriad of morphological types in the genus. Our collection of *O. micrantha* showed occasional chromosome bridges, but no other irregularities.

SUBFAMILY POOIDEAE

Calamagrostis intermedia, $n = 28$, consistently formed one to five quadrivalents at diakinesis (Fig. 6). Previously, we (Pohl & Davidse, 1971) determined the same number for another Costa Rican collection and noted other irregularities, bridges and laggards—but not multivalents—at metaphase and anaphase I.

SUBFAMILY CHLORIDOIDEAE

Muhlenbergia lehmanniana (Fig. 14) had one or two B-chromosomes in most of the cells examined, although some cells clearly lacked them. These chromo-

TABLE 1. Chromosome numbers of tropical American grasses.

Species	<i>n</i>	Voucher
Subfamily Bambusoideae		
<i>Chusquea</i> <i>scabra</i> Soders. & Cald.	20**	COSTA RICA. CARTAGO: 4 km NE of Capellades, <i>Pohl & Pinette</i> 13305. CARTAGO: 3 km W of Santa Cruz, <i>Pohl & Pinette</i> 13307.
<i>Olyra</i> <i>lateralis</i> (Presl) Chase	18**	PANAMÁ. PANAMÁ: Cerro Jefe, <i>Davidse & D'Arcy</i> 10102.
<i>latifolia</i> L.	22	VENEZUELA. BOLÍVAR: 17 km W of the Río Caura, <i>Davidse</i> 4442.
<i>micrantha</i> H.B.K.	20	VENEZUELA. BOLÍVAR: La Gran Sabana, KM 248, <i>Davidse et al.</i> 4920.
<i>Pharus</i> <i>glaber</i> H.B.K.	ca. 22	COSTA RICA. PUNTARENAS: Finca Las Cruces Botanical Garden, <i>Pohl & Lucas</i> 13127.
<i>Swallenochloa</i> <i>longiligulata</i> Soders. & Cald.	20**	COSTA RICA. SAN JOSÉ: Tres de Junio, <i>Pohl & Selva</i> 12842, 12843.
<i>subtessellata</i> (Hitchc.) McClure	20	COSTA RICA. SAN JOSÉ: 4.6 km NW of La Georgina, páramo, <i>Pohl & Lucas</i> 13137.
<i>weberbaueri</i> (Pilger) McClure vel sp. aff.	20**	COLOMBIA. CUNDINAMARCA: Between Bogotá and Choachí, <i>Davidse et al.</i> 5527.
Subfamily Oryzoideae		
<i>Luziola</i> <i>pittieri</i> Luces	12	VENEZUELA. APURE: Ca. 30 km NE of Mantecal, <i>Davidse et al.</i> 3828.
<i>Oryza</i> <i>latifolia</i> Desv.	24	COSTA RICA. GUANACASTE: Cañas, Finca La Pacifica, <i>Pohl & Selva</i> 12957.
Subfamily Arundinoideae		
<i>Gynerium</i> <i>sagittatum</i> (Aubl.) Beauv.	22	COSTA RICA. LIMÓN: Río Pacuare, 5 km NE Siquirres, <i>Pohl & Selva</i> 12896.
Subfamily Pooideae		
<i>Agrostis</i> <i>turrialbae</i> Mez	14**	COSTA RICA. CARTAGO: 20.6 km S. of Empalme, <i>Pinette</i> 1297.
<i>Calamagrostis</i> <i>intermedia</i> (Presl) Steud.	28	COSTA RICA. SAN JOSÉ: 4.6 km NW of La Georgina, <i>Pohl & Lucas</i> 13138.
<i>Cinna</i> <i>poaeformis</i> (H.B.K.) Scribn. & Merr.	14	COSTA RICA. CARTAGO: Volcán Irazú, 2700 m, <i>Pohl & Selva</i> 12875.
<i>Festuca</i> <i>chiriquensis</i> Swallen	14**	PANAMÁ. CHIRIQUÍ: Ca. 9 km WNW of Boquete, <i>Davidse & D'Arcy</i> 10312.
<i>Stipa</i> <i>hans-meyeri</i> Pilger	11**	COSTA RICA. SAN JOSÉ: Cerro Buena Vista, <i>Pohl & Selva</i> 12846.
<i>Trisetum</i> <i>tonduzii</i> Hitchc.	14	COSTA RICA. CARTAGO: Volcán Irazú, above Sanitario Duran, 2700 m, <i>Pohl & Selva</i> 12876.

TABLE 1. (Continued)

Species	<i>n</i>	Voucher
Subfamily Chloridoideae		
<i>Aristida</i>		
<i>capillacea</i> Lam.	11	COLOMBIA. VICHADA: Ca. 8 km N of Las Gaviotas, <i>Davidse & Llanos</i> 5148.
<i>recurvata</i> H.B.K.	11	COLOMBIA. VICHADA: Ca. 8 km N of Las Gaviotas, <i>Davidse & Llanos</i> 5134.
<i>riparia</i> Trin.	11**	VENEZUELA. BOLÍVAR: 36 km E of the Río Cuchivero, <i>Davidse</i> 4422.
<i>setifolia</i> H.B.K.	11**	VENEZUELA. GUÁRICO: Estación Biológica de Los Llanos, <i>Davidse</i> 2923. GUÁRICO: 15 km S of Las Mercedes, <i>Davidse</i> 4250.
<i>torta</i> (Nees) Kunth s. lat.	11**	VENEZUELA. BOLÍVAR: La Gran Sabana, KM 287, <i>Davidse et al.</i> 4911.
<i>venesuelae</i> Henr.	22**	VENEZUELA. ANZOÁTEGUI: 6 km ESE of La Ceiba, <i>Davidse et al.</i> 4519.
<i>Bouteloua</i>		
<i>williamsii</i> Swallen	10	MEXICO. OAXACA: Ca. 12 mi NW of El Camarón, <i>Davidse & Davidse</i> 9597.
<i>Eragrostis</i>		
<i>mexicana</i> (Hornem.) Link	30	COSTA RICA. ALAJUELA: 3 km S of the Palmares exit, <i>Pohl & Lucas</i> 12946.
<i>Eustachys</i>		
<i>petraea</i> (Swartz) Desf.	20	MEXICO. VERACRUZ: 5 mi E of Coatzacoalcos, <i>Davidse & Davidse</i> 9338.
<i>Gouinia</i>		
<i>latifolia</i> (Griseb.) Vasey	40	VENEZUELA. BOLÍVAR: 21 km E of the Río Caura, <i>Davidse</i> 4465. COLOMBIA. CUNDINAMARCA: 14 km WNW of Melgar, <i>Davidse et al.</i> 5794.
<i>Gymnopogon</i>		
<i>fastigiatus</i> Nees	20	COLOMBIA. META: 73 km W of Las Gaviotas, <i>Davidse & Llanos</i> 5400.
<i>foliosus</i> (Willd.) Nees	10	VENEZUELA. BOLÍVAR: 28 km W of the Río Caura, <i>Davidse</i> 4424.
<i>spicatus</i> (Spreng.) Kuntze	10**	BRAZIL. DISTRITO FEDERAL: 3 km W of the Goias-Distrito Federal border on Highway BR 020-030, <i>Davidse et al.</i> 12166.
<i>Muhlenbergia</i>		
<i>lehmanniana</i> Henr.	10 + 2B**	PANAMÁ. CHIRIQUÍ: Ca. 3 km NE of El Hato del Volcán, <i>Davidse & D'Arcy</i> 10332.
<i>setarioides</i> Fourn.	20	COSTA RICA. CARTAGO: Between Llano Grande and Tierra Blanca, <i>Pohl & Lucas</i> 13097.
<i>Pappophorum</i>		
<i>pappiferum</i> (Lam.) Kuntze s. lat.	50*	VENEZUELA. ANZOÁTEGUI: 18 km W of El Tigre, <i>Davidse et al.</i> 4976. BOLÍVAR: 13 km ESE of Upata, <i>Davidse et al.</i> 4615.
<i>Pereilema</i>		
<i>brasilianum</i> Trin.	20**	BRAZIL. GOIAS: 18 km of Alvarada do Norte <i>Davidse et al.</i> 12214.
<i>Sporobolus</i>		
<i>jacquemontii</i> Kunth	12	COSTA RICA. PUNTARENAS: Paso Real, <i>Pohl & Selva</i> 12847.
<i>virginicus</i> (L.) Kunth	10	MEXICO. VERACRUZ: 5 mi E of Coatzacoalcos, <i>Davidse & Davidse</i> 9339.

TABLE 1. (Continued)

Species	<i>n</i>	Voucher
Subfamily Panicoideae		
<i>Acroceras</i>		
<i>zizanioides</i> (H.B.K.) Dandy	18	COLOMBIA. META: 20 km W of Puerto López, <i>Davidse & Llanos</i> 5495.
<i>Andropogon</i>		
<i>hypogynous</i> Hack.	30**	COLOMBIA. META: 2 km E of Puerto Gaitán, <i>Davidse & Llanos</i> 5404.
<i>Axonopus</i>		
<i>capillaris</i> (Lam.) Chase	20	VENEZUELA. GUÁRICO: Ca. 50 km N of San Fer- nando de Apure, <i>Davidse et al.</i> 3824.
<i>fissifolius</i> (Raddi) Kuhlman	30*	VENEZUELA. BOLÍVAR: 35 km E of the Río Cuchi- vero, <i>Davidse</i> 4421.
<i>pruinusus</i> Henr.	30**	VENEZUELA. BOLÍVAR: 32 km N of La Ciudadella, <i>Davidse et al.</i> 4955.
<i>Brachiaria</i>		
<i>fasciculata</i> (Swartz) Parodi	9	COSTA RICA. GUANACASTE: Cañas, Finca La Pa- cífica, <i>Pohl & Selva</i> 12958.
<i>Digitaria</i>		
<i>abyssinica</i> (Hochst.) Stapf	18	COSTA RICA. HEREDIA: Alto de Roble, <i>Pohl &</i> <i>Lucas</i> 13001.
<i>bicornis</i> (Lam.) R. & S.	36	VENEZUELA. SUCRE: Cumaná, <i>Davidse</i> 5022. MEXICO. VERACRUZ: 5 mi E of Coatzacoalcos, <i>Davidse & Davidse</i> 9345.
<i>ciliaris</i> (Retz.) Koel	27	COSTA RICA. ALAJUELA: Near Palmares, <i>Pohl &</i> <i>Selva</i> 12950.
<i>Echinolaena</i>		
<i>gracilis</i> Swallen	10	COLOMBIA. META: 73 km W of Los Gaviotas, <i>Davidse & Llanos</i> 5394. VENEZUELA. GUÁRICO: Ca. 21 km SE of Calabozo, <i>Davidse</i> 3739.
<i>Eriochloa</i>		
<i>punctata</i> (L.) Desv.	18	VENEZUELA. GUÁRICO: Río Orituco, <i>Davidse</i> 3719.
<i>Euclasta</i>		
<i>condylotricha</i> (Hochst. ex Steud.) Stapf	10	VENEZUELA. GUÁRICO: 10 km NWN of Altagracia de Orituco, <i>Davidse</i> 4186.
<i>Homolepis</i>		
<i>aturensis</i> (H.B.K.) Chase	10	MEXICO. TABASCO: 4 km W of Huimanguillo, <i>Davidse & Davidse</i> 9365.
<i>Hymenachne</i>		
<i>amplexicaulis</i> (Rudge) Nees	10	VENEZUELA. APURE: Near Mantecal, <i>Davidse et</i> <i>al.</i> 3869. COLOMBIA. META: 20 km W of Puerto López, <i>Davidse & Llanos</i> 5496.
<i>Hypogynium</i>		
<i>virgatum</i> (Desv. ex Hamilt.) Dandy	10	COLOMBIA. VICHADA: Ca. 51 km E of Las Gaviotas, <i>Davidse & Llanos</i> 5239.
<i>Ichnanthus</i>		
<i>nemorosus</i> (Swartz) Doell	ca. 20	COSTA RICA. HEREDIA: Alto de Roble, <i>Pohl &</i> <i>Lucas</i> 13000.
<i>Isachne</i>		
<i>polygonoides</i> (Lam.) Doell	10	VENEZUELA. GUÁRICO: Ca. 32 km SSE of Calabozo, <i>Davidse</i> 3772.
<i>Ischaemum</i>		
<i>indicum</i> (Houtt.) Merr.	10	COSTA RICA. LIMÓN: 2 km W of Bambu, <i>Pohl &</i> <i>Pinette</i> 13195.
<i>rugosum</i> Salisb.	9	VENEZUELA. GUÁRICO: 23 km NE of Chagauramas, <i>Davidse</i> 4230. GUÁRICO: ca. 50 km N of San Fernando de Apure, <i>Davidse et al.</i> 3822.

TABLE 1. (Continued)

Species	n	Voucher
<i>Otachyrium</i>		
<i>versicolor</i> (Doell) Henr.	10	VENEZUELA. APURE: 42 km NE of Mantecal, <i>Davidse et al.</i> 3910.
<i>Panicum</i>		
<i>cordovense</i> Fourn.	27	COSTA RICA. SAN JOSÉ: 21 km S of Cartago, <i>Pohl & Lucas</i> 13004.
<i>glutinosum</i> Swartz	20	PANAMÁ. PANAMÁ: Cerro Jefe, <i>Davidse & D'Arcy</i> 10117. MEXICO. CHIAPAS: Ca. 8 mi NE of Solistohuacan, <i>Davidse & Davidse</i> 9446. VENEZUELA. DISTRITO FEDERAL: Road to Carayaca, <i>Davidse & Morillo</i> 4004.
<i>guianense</i> Hitchc.	20**	VENEZUELA. GUÁRICO: Río Orituco, <i>Davidse</i> 3716.
<i>laxum</i> Swartz	20	COSTA RICA. GUANACASTE: Cañas, Finca La Pacifica, <i>Pohl & Selva</i> 12959.
<i>macranthum</i> Trin.	27**	BRAZIL. BAHIA: 15 km S of intersection of Highway BR-020 and Río Roda Velha, <i>Davidse et al.</i> 12085.
<i>mertensii</i> Roth.	20	COLOMBIA. META: 20 km W of Puerto López, <i>Davidse & Llanos</i> 5500.
<i>olivaceum</i> Hitchc. & Chase	9	PANAMÁ. CHIRIQUÍ: Ca. 9 km WNW of Boquete, <i>Davidse & D'Arcy</i> 10308.
<i>olyroides</i> H.B.K.	18**	COLOMBIA. VICHADA: Ca. 8 km N of Las Gaviotas, <i>Davidse & Llanos</i> 5132.
<i>parvifolium</i> Lam.	18	COLOMBIA. META: 73 km W of Las Gaviotas, <i>Davidse & Llanos</i> 5401.
<i>pilosum</i> Swartz	10	COLOMBIA. CAQUETÁ: 23 km N of Florencia, <i>Davidse et al.</i> 5760.
<i>pyrularium</i> Hitchc. & Chase	18**	COLOMBIA. META: 14 km NW of Villavicencio, <i>Davidse & Llanos</i> 5518.
<i>rudgei</i> R. & S.	9	COLOMBIA. META: 43 ENE of Puerto López, <i>Davidse & Llanos</i> 5106. COSTA RICA. PUNTARENAS: Savannas of Buenos Aires, <i>Pohl & Lucas</i> 13116.
<i>sphaerocarpum</i> Ell.	9	PANAMÁ. CHIRIQUÍ: E slope of Volcán de Chiriquí, <i>Davidse & D'Arcy</i> 10153.
<i>trichanthum</i> Nees	18	COSTA RICA. LIMÓN: Cahuita, <i>Pohl & Selva</i> 12914.
<i>trichoides</i> Swartz	9	VENEZUELA. GUÁRICO: 15 km SW of Tamaco, <i>Davidse</i> 4213.
<i>Paspalum</i>		
<i>botterii</i> (Fourn.) Chase	40	COSTA RICA. GUANACASTE: Hacienda Paloverde, <i>Pohl & Selva</i> 12938.
<i>carinatum</i> Humb. & Bonpl. ex Flügge	10*	VENEZUELA. BOLÍVAR: 31 km W of Caicara, <i>Davidse</i> 4366.
<i>decumbens</i> Swartz	10	COLOMBIA. CAQUETÁ: 23 km N of Florencia, <i>Davidse et al.</i> 5761.
<i>gardnerianum</i> Nees	ca. 20**	COLOMBIA. VICHADA: Ca. 10 km W of Las Gaviotas, <i>Davidse & Llanos</i> 5360.
<i>minus</i> Fourn.	25*	COSTA RICA. PUNTARENAS: 8 km E. of Esparza, <i>Pohl & Selva</i> 12954.
<i>minus</i> Fourn.	ca. 20	COLOMBIA. VICHADA: 31 km W of Las Gaviotas, <i>Davidse & Llanos</i> 5378.
<i>multicaule</i> Poir.	10	VENEZUELA. GUÁRICO: Ca. 32 km SSE of Calabozo, <i>Davidse</i> 3773. COLOMBIA. VICHADA: Ca. 8 km N of Las Gaviotas, <i>Davidse & Llanos</i> 5127.

TABLE 1. (Continued)

Species	<i>n</i>	Voucher
<i>notatum</i> Flügge	20	COSTA RICA. GUANACASTE: Cañas, Finca La Pacifica, <i>Pohl & Selva</i> 12960.
<i>pectinatum</i> Nees	10	COLOMBIA. VICHADA: Ca. 25 km E of Cumaribo, <i>Davidse & Llanos</i> 5321.
<i>plicatulum</i> Michx.	10	MEXICO. TABASCO: 4 km W of Huimanguillo, <i>Davidse & Davidse</i> 9363.
<i>reclinatum</i> Chase	30	COSTA RICA. CARTAGO: Canyon of Río Grande de Orosí, S of Tapantí, <i>Pohl & Selva</i> 12882.
<i>virgatum</i> L.	20	COSTA RICA. LIMÓN: 2 km W of Bambu, <i>Pohl & Pinette</i> 13199. MEXICO. TABASCO: 4 km W of Huimanguillo, <i>Davidse & Davidse</i> 9356.
<i>Pennisetum</i>		
<i>setosum</i> (Swartz) L. Rich.	18*	COLOMBIA. VICHADA: Ca. 35 km E of Las Gaviotas, <i>Davidse & Llanos</i> 5194.
<i>setosum</i> (Swartz) L. Rich.	ca. 36	VENEZUELA. GUÁRICO: 10 km NWN of Altagracia de Orituco, <i>Davidse</i> 4187.
<i>Sacciolepis</i>		
<i>myuros</i> (Lam.) Chase	18	VENEZUELA. BOLÍVAR: 27 km SW of Caicara, <i>Davidse</i> 4353.
<i>Urochloa</i>		
<i>reptans</i> (L.) Stapf	7	COSTA RICA. GUANACASTE: Hacienda Paloverde, <i>Pohl & Selva</i> 12942.

* First count for a species.
** Count differing from all previously reported ones for a species.

somes seemed more sharply contracted and stained less deeply than the normal bivalents. When two were present in a cell, they failed to pair, although they often were in close proximity. Meiosis was normal in other respects.

We have already reported $n = 30$ for two Venezuelan collections of *Pappophorum pappiferum* (Davidse & Pohl, 1974). Two other Venezuelan collections have $n = 50$ (Fig. 15). This species complex obviously is a derived polyploid complex with perplexing morphological variability. It seems probable that the different ploidy levels can be correlated with morphological differences. On the basis of morphology, the Venezuelan decaploids appear closely related to the decaploid populations of *P. bicolor* Fourn. known from Mexico and the southwestern United States (Gould, 1958, 1966; Reeder, 1968). Detailed cytotaxonomic studies may further elucidate the origin and relationships of these polyploids.

SUBFAMILY PANICOIDEAE

Chromosome numbers for three small American genera have been reported only in the last few years, but base numbers have not been established unequivocally because various investigators have reported different numbers for different species of the same genus or for the same species. Our two additional counts of $n = 10$ for *Echinolaena gracilis* from Venezuela and Colombia confirm one of our earlier counts for this species from Venezuela (Davidse & Pohl, 1974), but differ from the $2n = 18$ that we reported for a Costa Rican collection (Pohl & Davidse, 1971). Taking into consideration the count of $2n = 60$ reported for



FIGURES 1-13. First meiotic division in microsporocytes. Scale line equals 10 $m\mu$.—1. *Chusquea scabra*, $n = 20$, diakinesis.—2. *Olyra lateralis*, $n = 18$, anaphase.—3. *Swallenochloa weberbaueri*, $n = 20$, diakinesis.—4. *Swallenochloa longiligulata*, $n = 20$, diakinesis.—5. *Agrostis turrialbae*, $n = 14$, anaphase.—6. *Calamagrostis intermedia*, diakinesis with

E. inflexa (Poir.) Chase by Gould & Soderstrom (1967), there now seems little doubt that $x = 10$ is the base number for this genus. The count of $n = 10$ for a Mexican collection of *Homolepis aturensis* agrees with an earlier count of $2n = 20$ for a Costa Rican collection (Pohl & Davidse, 1971), although Gould & Soderstrom (1970) reported $2n = 22$ from Colombia. Our counts, plus $2n = 40$ reported by Gould & Soderstrom (1967) for *H. isocalycia* (Meyer) Chase, definitely point to $x = 10$ as a base number. *Otachyrium versicolor* from Brazil was reported to have the approximate number $2n = 18$ by Gould & Soderstrom (1967). We obtained a definite count of $n = 10$ for this species. This, along with the earlier count of $n = 10$ for *O. inaequale* (Pilger) Pilger (Davidse & Pohl, 1974), firmly establishes the base number $x = 10$ for the genus.

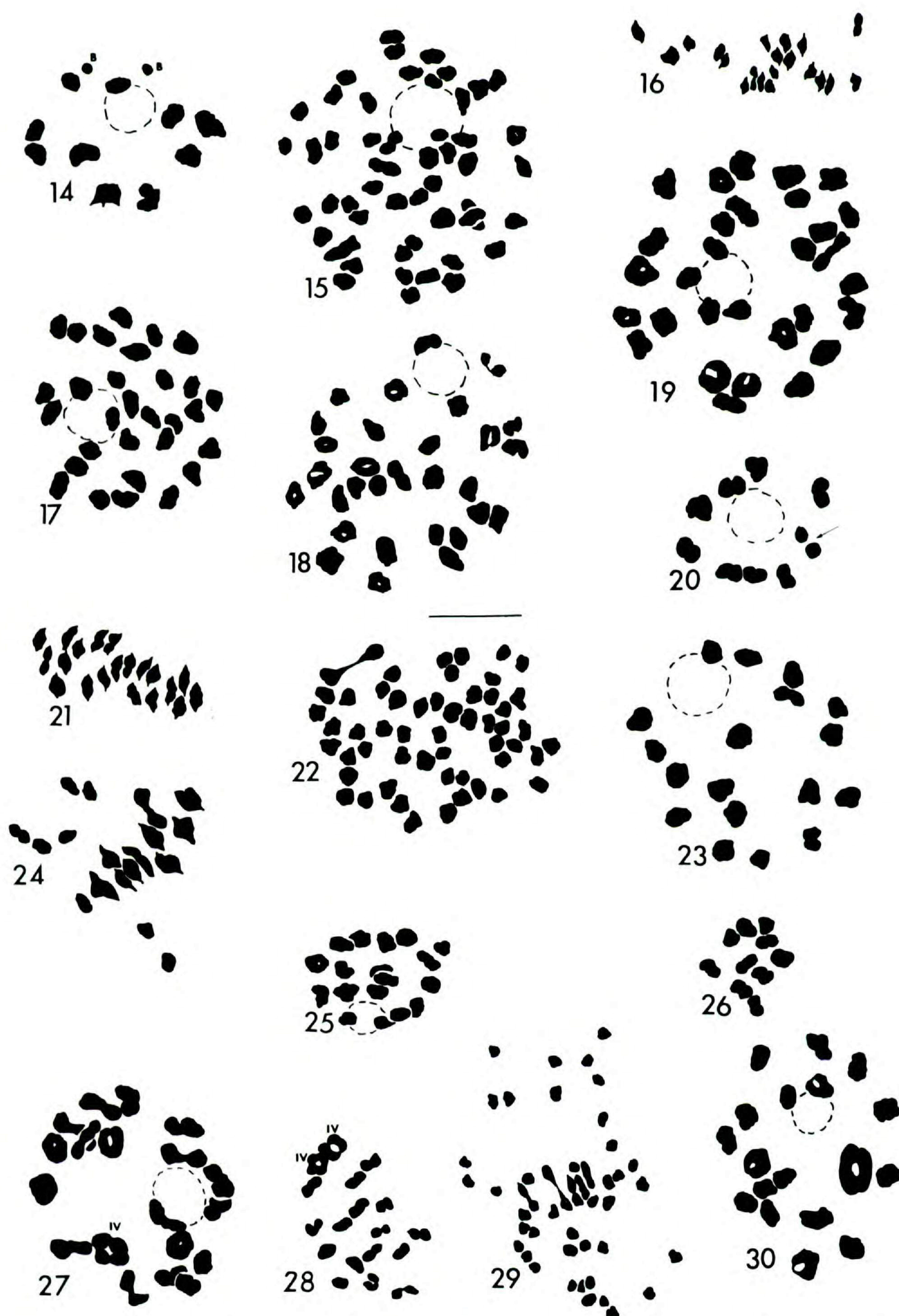
Although we could not reconfirm the exact count of $n = 20$ for *Ichnanthus nemorosus* (Tateoka, 1962; Reeder, 1967; Pohl & Davidse, 1971; Davidse & Pohl, 1972a, 1972b), we could confirm the probable tetraploid nature of our current collection. We also noted the consistent presence of lagging univalents at anaphase I. Because of limited material, no further study of these irregularities could be made. Recent students of the genus *Ichnanthus* differ widely in their estimates of the number of species. The plants display perplexing morphological variability in the field and great cytological complexity as well. The genus is in definite need of further biosystematic study.

No unanimity exists as to the chromosome numbers of two species of *Ischaemum*, *I. indicum*, and *I. rugosum*. Counts given for *I. indicum* (including *I. ciliare*) indicate base numbers of $x = 9$ and $x = 10$ and also show the existence of diploids, tetraploids, and hexaploids based on these numbers. Individual counts were reported as $n = 9$ from Costa Rica (Pohl & Davidse, 1971); $n = 18$ from Taiwan (Chen & Hsu, 1962) and from Sri Lanka (Gould & Soderstrom, 1974); $n = 27$ from Costa Rica (Celarier, 1957). Counts of $n = 10$ were from Costa Rica (present paper), Indonesia (Reeder & Soderstrom, 1968), India (Oke, 1971). A tetraploid with $n = 20$ was reported from India (Sindhe & Narayan, 1976). An aneuploid count of $n = 26$ was reported by Mehra & Sood (1974) from India. Obviously, a definitive study of this species is yet to be made, and this should include an analysis of reproductive methods to determine whether apomixis is involved.

Our current count for *I. rugosum* indicates $n = 9$, and three previous reports based upon four New World and one Indian accessions agree with this number (Celarier, 1957; Pohl & Davidse, 1971; Davidse & Pohl, 1974). Counts based on other Indian accessions have differed. Oke (1971) reported $n = 10, 20, 30$ for three different collections, Singh & Godward (1960) reported $2n = 20$ for one collection, and Sindhe & Narayan (1976) reported $2n = 44$ for one collection. In our material, we noted two chromosomes that consistently paired very loosely

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5_{IV} + 18_{II}.—7. *Festuca chiriquensis*, $n = 14$, diakinesis.—8. *Stipa hans-meyeri*, $n = 11$, diakinesis.—9. *Aristida riparia*, $n = 11$, diakinesis.—10. *Aristida setifolia*, $n = 11$, diakinesis.—11. *Aristida torta*, $n = 11$, diakinesis.—12. *Aristida venesuelae*, $n = 22$, diakinesis.—13. *Gymnopogon spicatus*, $n = 10$, diakinesis.



FIGURES 14-30. First meiotic division in microsporocytes. Scale line equals 10 $m\mu$.—14. *Muhlenbergia lehmanniana*, $n = 10 + 2B$, diakinesis.—15. *Pappophorum pappiferum*, $n = 50$, diakinesis.—16. *Pereilema brasiliensis*, $n = 20$, metaphase.—17. *Andropogon hypogynous*, $n = 30$, diakinesis.—18. *Axonopus fissifolius*, $n = 30$, diakinesis.—19. *Axonopus pruinosis*,

in diakinesis (Fig. 20), and the interpretation of such figures may account for some of the reported differences.

Panicum macranthum, previously unknown cytologically, is a hexaploid ($n = 27$) with irregular meiosis. Very loose pairing was characteristic of diakinesis in our fixation. In all cells examined, one or two quadrivalents and/or hexavalents were observed. Bridges were commonly observed at anaphase I (Fig. 22), and excluded chromosomes and/or fragments were commonly observed at the later stages of both meiotic divisions. *Panicum parvifolium*, known as a diploid ($2n = 18$) from Madagascar (Tateoka, 1965) and as a tetraploid ($2n = 36$) from Costa Rica (Pohl & Davidse, 1971), is tetraploid in Colombia. In our Colombian material, 9 large and 9 small bivalents were observed. Viewed only at metaphase I, the small bivalents could easily have been interpreted as univalents inasmuch as they had a tendency to align themselves tardily on the metaphase plate (Fig. 24). However, both anaphase I and anaphase II were normal, 18 chromosomes segregating to each pole. Furthermore, all pollen seemed fully formed, further negating the possibility of a $9_{II} + 9_I$ interpretation.

Paspalum carinatum, a characteristic species of South American savannas was previously known as a tetraploid, $n = 20$, at the periphery of its distribution in Nicaragua (Davidse & Pohl, 1972b). The present determination of a Venezuelan collection is diploid, $n = 10$, with regular meiosis (Fig. 26). Our first count for *Paspalum gardnerianum* shows it to be a tetraploid with $n = \text{ca. } 20$ (Fig. 27). The sticky chromosomes of the material made it difficult to interpret the chromosome associations; hence, our count is tentative. Some cells, however, clearly showed up to three quadrivalents. Our Costa Rican collection of *Paspalum minus*, $n = 25$, also had meiotic irregularities. Although the majority of the chromosomes seemed at least loosely paired in diakinesis, we never observed more than 5 bivalents (Fig. 28) and sometimes as few as two in metaphase I. This is the first report of a pentaploid in this species, although diploids (Banks, 1966), tetraploids (Gould, 1958), and hexaploids (Moraes Fernandes et al., 1974) have been reported. It is likely that our collection is of hybrid origin and that the meiotic irregularities, not reported before in this species nor in our tetraploid collection from Colombia, can be traced to this origin. In *Paspalum notatum* from Costa Rica, we observed one or two quadrivalents in all the numerous cells examined (Fig. 29). Such multivalent associations in the tetraploid race of the species also have been noted by Forbes & Burton (1961) and Moraes Fernandes et al. (1974).

We found *Pennisetum setosum* to be octoploid with irregular meiosis, $n = \text{ca.}$

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$n = 30$, diakinesis.—20. *Ischaemum rugosum*, $n = 9$, diakinesis, arrow indicates loosely paired chromosomes.—21. *Panicum guianense*, $n = 20$, metaphase.—22. *Panicum macranthum*, $n = 27$, anaphase with one bridge.—23. *Panicum olyroides*, $n = 18$, diakinesis.—24. *Panicum parviflorum*, $n = 18$, metaphase with 9 large and 9 small bivalents.—25. *Panicum pyrularium*, $n = 18$, diakinesis.—26. *Paspalum carinatum*, $n = 10$, metaphase.—27. *Paspalum gardnerianum*, $n = \text{ca. } 20$, diakinesis with 1 quadrivalent.—28. *Paspalum minus*, metaphase with $5_{II} + 40_I$.—29. *Paspalum notatum*, diakinesis with $2_{IV} + 16_{II}$.—30. *Pennisetum setosum*, $n = 18$, diakinesis with 1 unusually large bivalent.

36, in one Venezuelan collection and tetraploid with regular meiosis, $n = 18$, in a Colombian collection. The latter is the lowest ploidy level known for this species. This tetraploid also had an unusually large chromosome pair, very similar in size to a quadrivalent (Fig. 30). Previous records for this species have been $2n = 53$ with irregular meiosis (Pohl & Davidse, 1971), $2n = 54$ (Avdulov, 1928), $n = 36$ with irregular meiosis (Davidse & Pohl, 1972a), and $2n = 78$ with irregular meiosis (Gould, 1965). As we have noted earlier, the irregular meiosis and different ploidy levels probably are the result of an apomictic breeding system (Pohl & Davidse, 1971).

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